Upper Great Lakes Storm Track Climatology 2006-2012

John Boris
National Weather Service Gaylord MI
2012 Winter Talk Series

What are we referring to when we talk about "storm tracks"?

A storm track is the path that an area of low pressure takes during its lifetime...from initial development to dissipation.

It has long been recognized that there are preferred areas of low pressure development...or what meteorologists refer to as "cyclogenesis". Where a storm system initially develops can have a large influence on its future impacts on downstream locations.

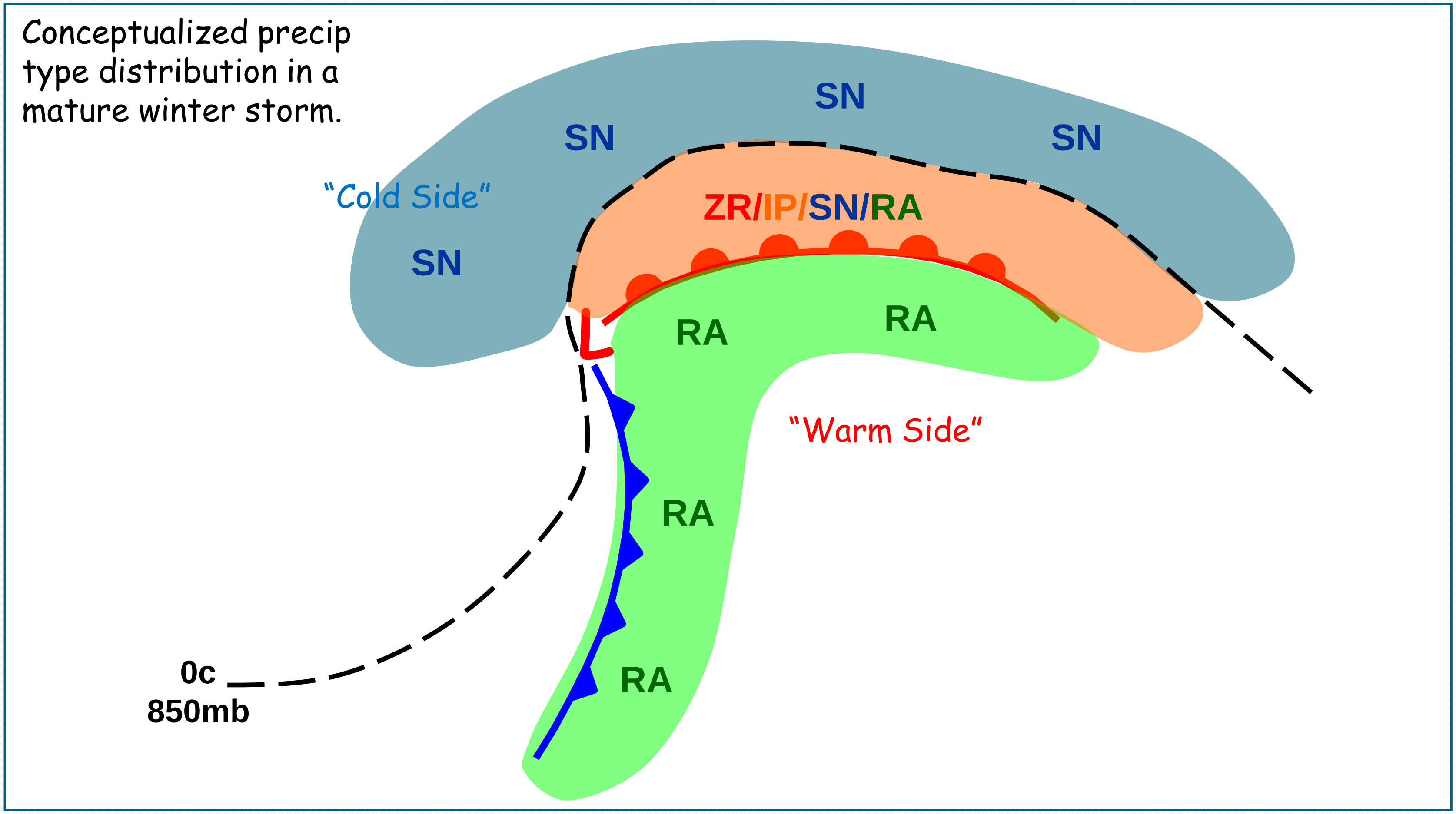
So why is knowing the track of a storm important?

One of the biggest reasons storm track is important is due to the temperature structure around a major storm system. Whether you are on the “warm” or “cold” side of a storm has a major impact on what type (or types) of precipitation you may receive.

Another important aspect of storm track is precipitation amount...especially when dealing with snowfall.

This is why forecasters spend a lot of time trying to determine an accurate storm track for winter storms...given the many implications based on exactly where a low pressure system will go.

Conceptual Model of a Typical Winter Storm



What is a storm track climatology?

A storm track climatology is tracing the history of storm systems over a given number of years.

This can give insight into where storms typically form. In the case of this study...we wanted to look at where storms that impact the Upper Great Lakes region typically develop.

Study methodology…or how we did what we did!

This study encompassed our six most recent "cool seasons"…defined as the period from October through March.

We looked at storm tracks starting with the cool season of October 2006-March 2007…and continued through the cool season of October 2011-March 2012.

Storm Track Database:

In order to be counted in our database, each storm track had to meet the following criteria:

Track: A low pressure center need to cross the boxed area outlined below at some point in its lifecycle:

The box covers the area between longitude 79º and 90º west...and latitude 41º and 49º north.

This was intended to capture storms that were most likely to have an impact on northern Michigan.

Storm Track Database:

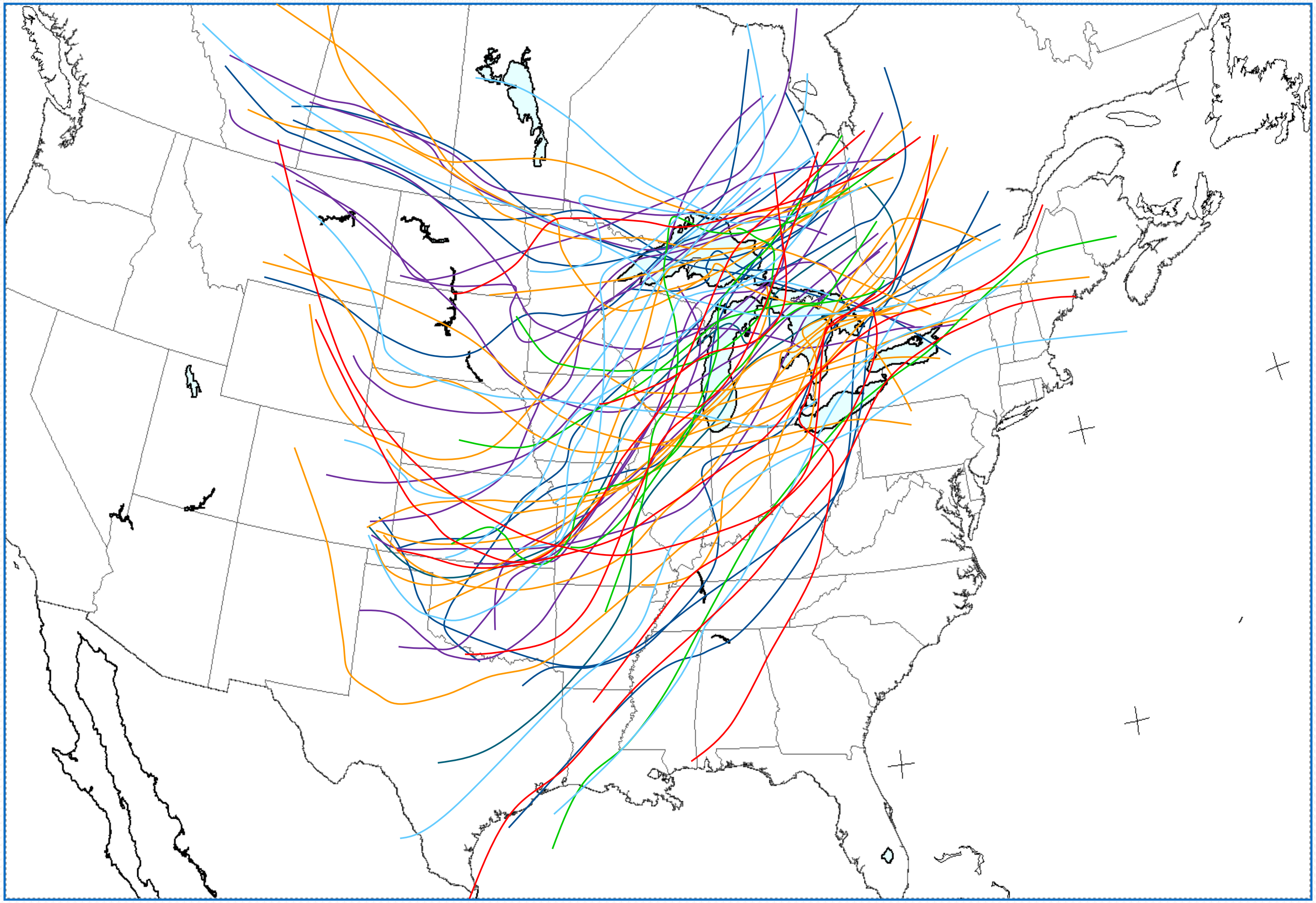
In order to be counted in our database, each storm track had to meet the following criteria:

Strength: Each storm had to have a minimum pressure below 1000mb (approximately 29.50 inches of mercury).

This was intended to capture systems most likely to have a significant impact on northern Michigan weather.

This resulted in a database containing 73 storm tracks over the six cool season period.

Storm Tracks Map



Legend:

2006-07:

2007-08:

2008-09:

2009-10:

2010-11:

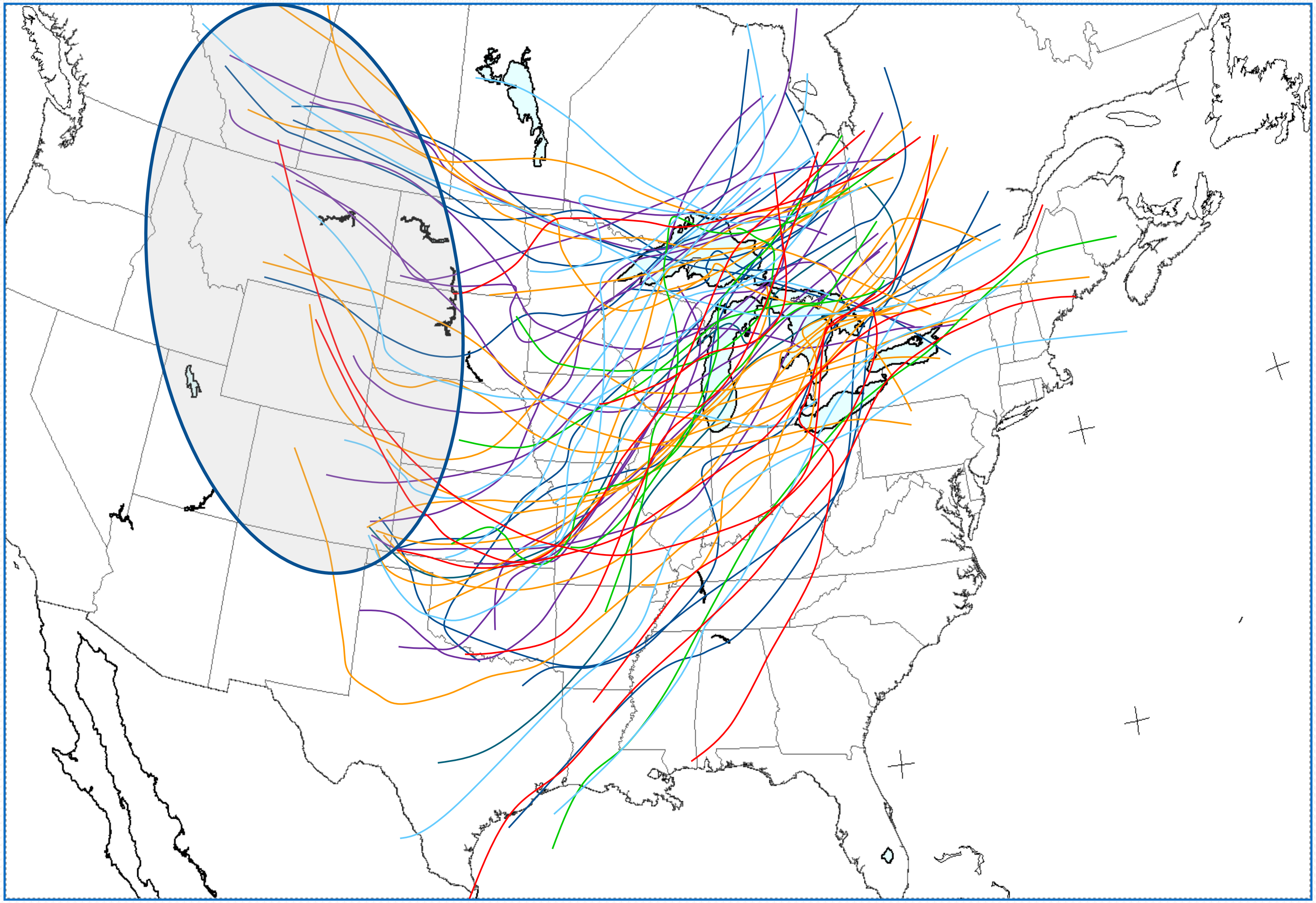
2011-12:

So...what does that spaghetti mess on the previous slide tell us?

We'll break this map down a bit in order to highlight important trends.

But first, let's take a general look at where these areas of low pressure are developing...

Notice that none of the lows developed in the westernmost portions of the U.S. or Canada. But there is a strong tendency for lows to form immediately downwind of the Rocky Mountains. Interesting....



Legend:

2006-07:

2007-08:

2008-09:

2009-10:

2010-11:

2011-12:

Lee Side Cyclogenesis

It turns out that the barrier of the Rocky Mountains has a two fold impact on low pressure development.

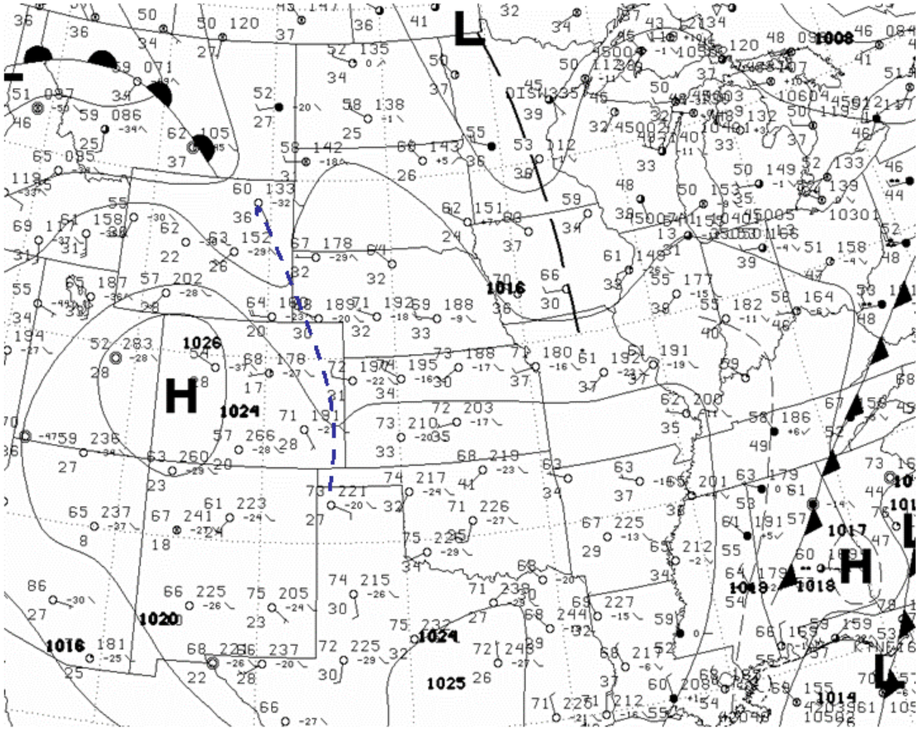
The Rockies (and the mountainous terrain out west in general) tend to weaken storm systems coming in off the Pacific Ocean.

But downwind of the Rockies (the lee side)...winds descending from the higher terrain can result in a trough of low pressure developing east of the mountain range.

Disturbances within the jet stream can then interact with this lee side trough...and form a low pressure circulation.

Lee Side Cyclogenesis

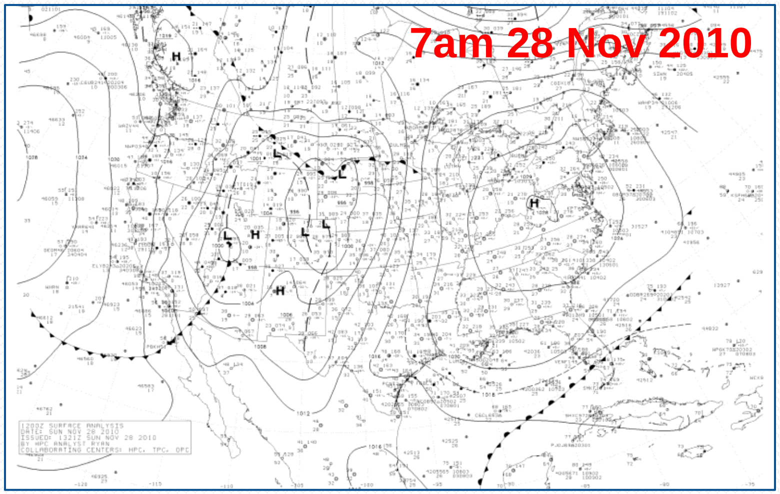
Lee Trough: 2100 UTC 01 Nov 2005

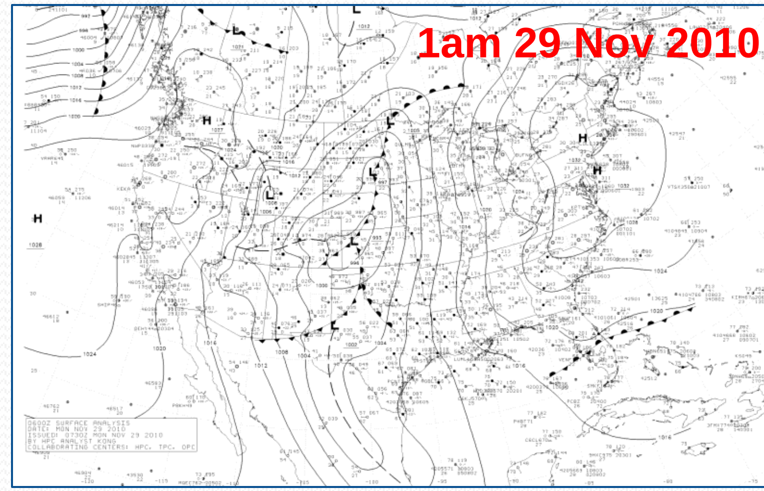


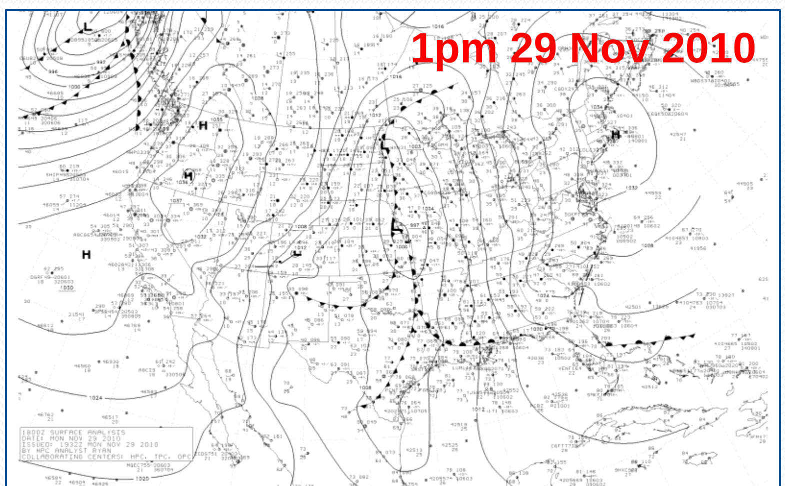
An example of a lee trough on a surface weather map.

One of the simple reasons for the development of low pressure troughs downwind of mountain ranges (simple in that it doesn't involve heavy math to explain it) is that air moving down a mountain slope warms as it descends. This warming contributes to a lowering of surface pressure.

Lee Cyclogenesis Example



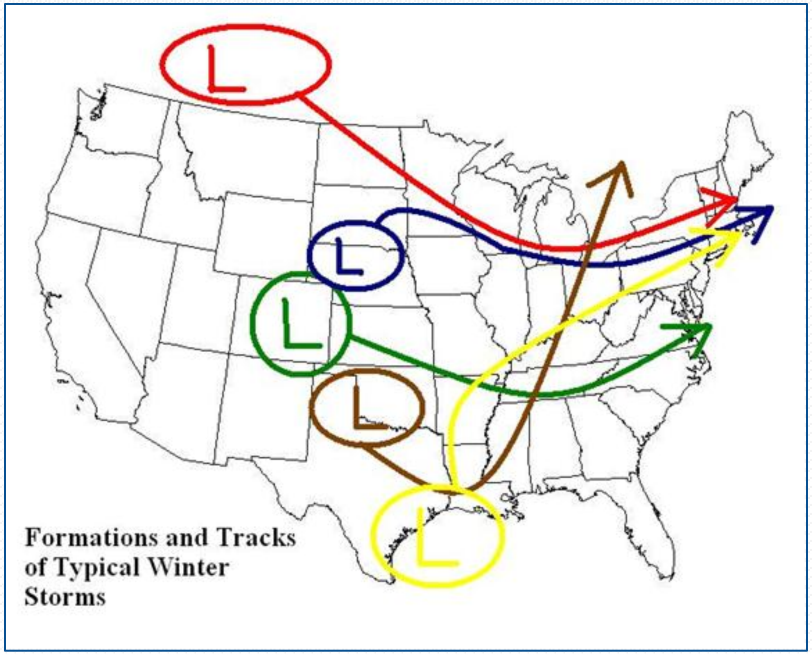




Cyclogenesis "Geography"

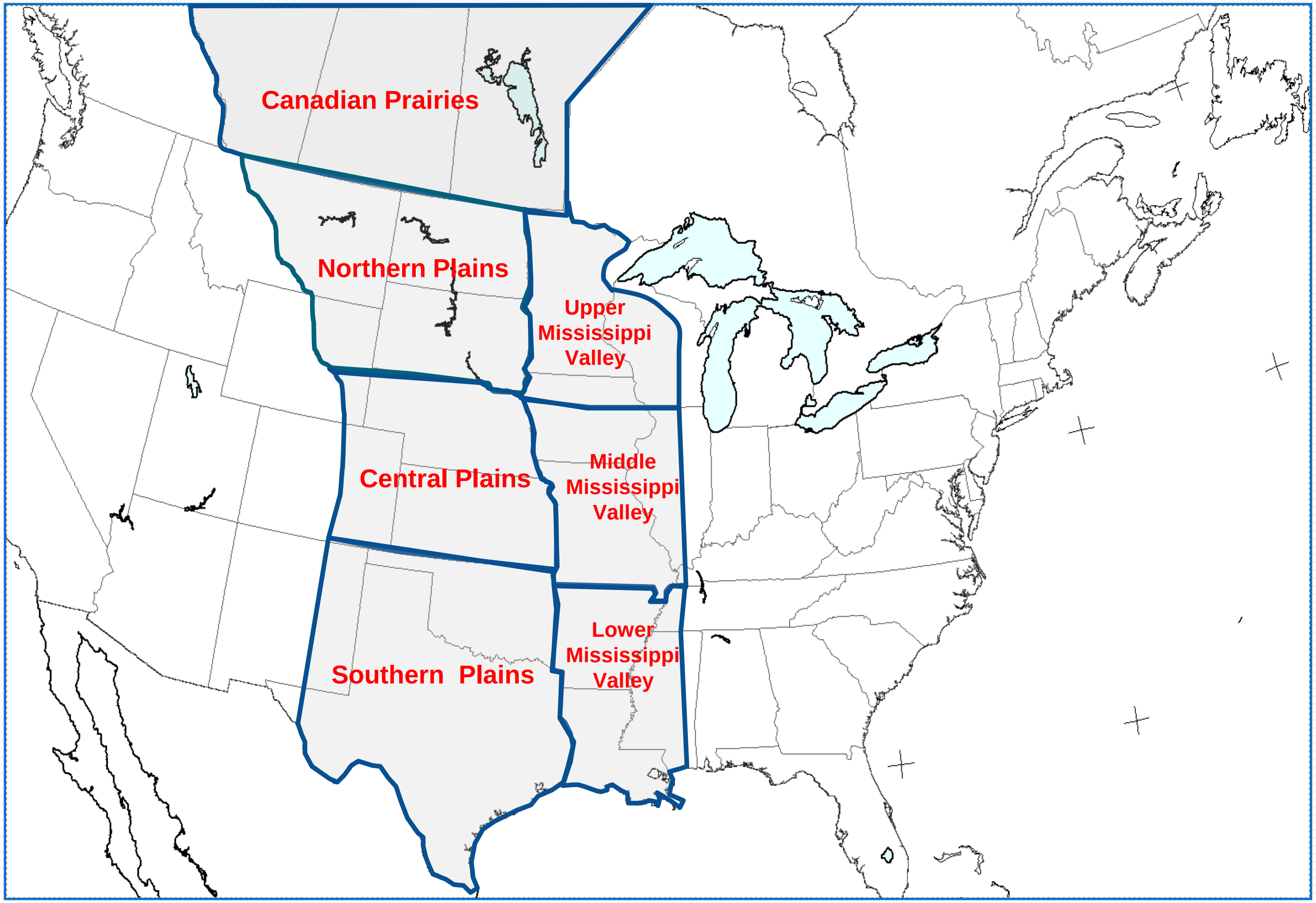
While the lee side of large mountain ranges are favored areas for low pressure development...it also turns out that cyclogenesis often occurs over specific areas.

Many studies over the years have shown typical areas for cyclone development and their subsequent movement. An example is shown below.

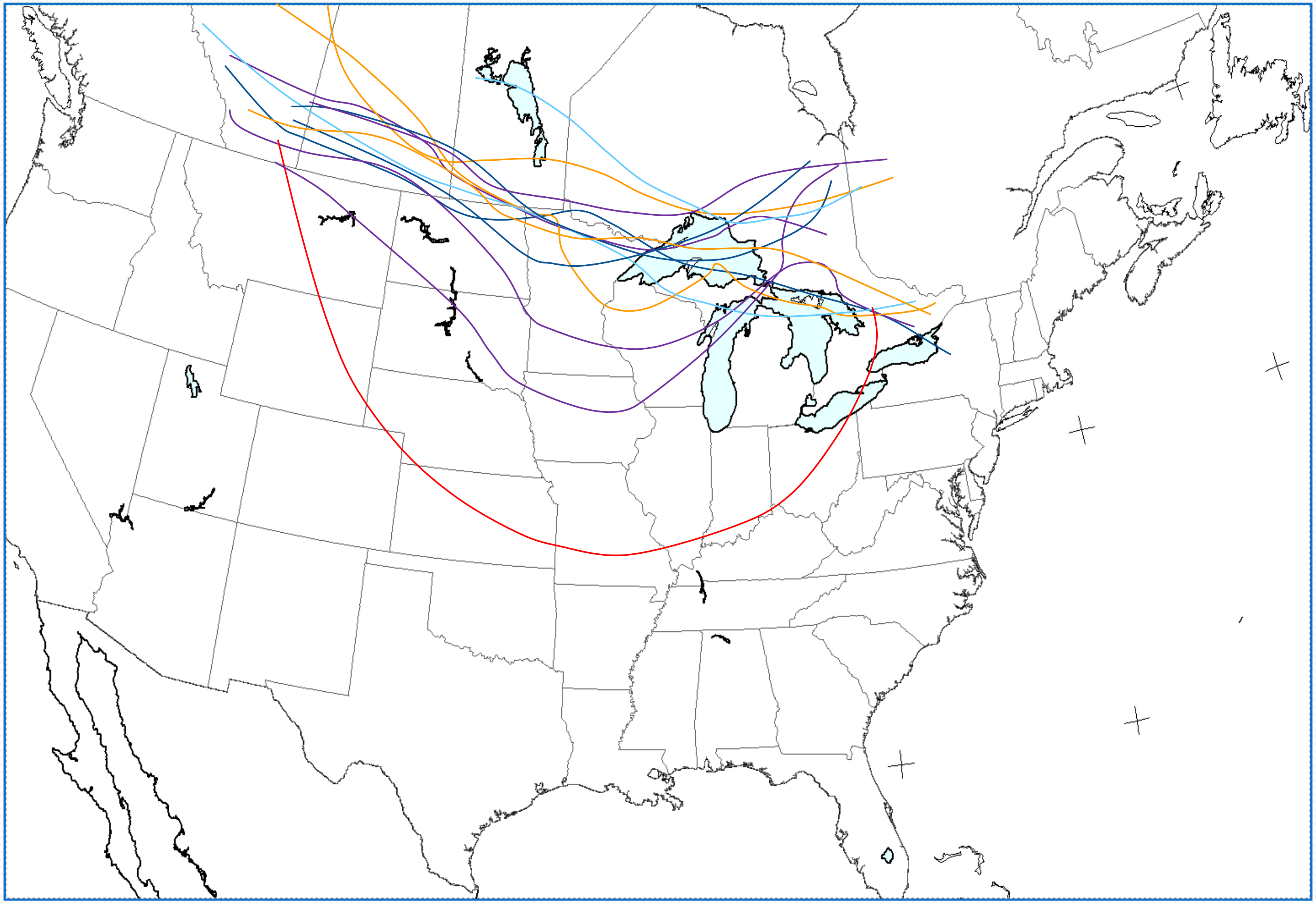


We can also divide our map up into geographic regions and show where Great Lakes storm systems typically develop.

Geographic Regions



Geographic Region: Canadian Prairies



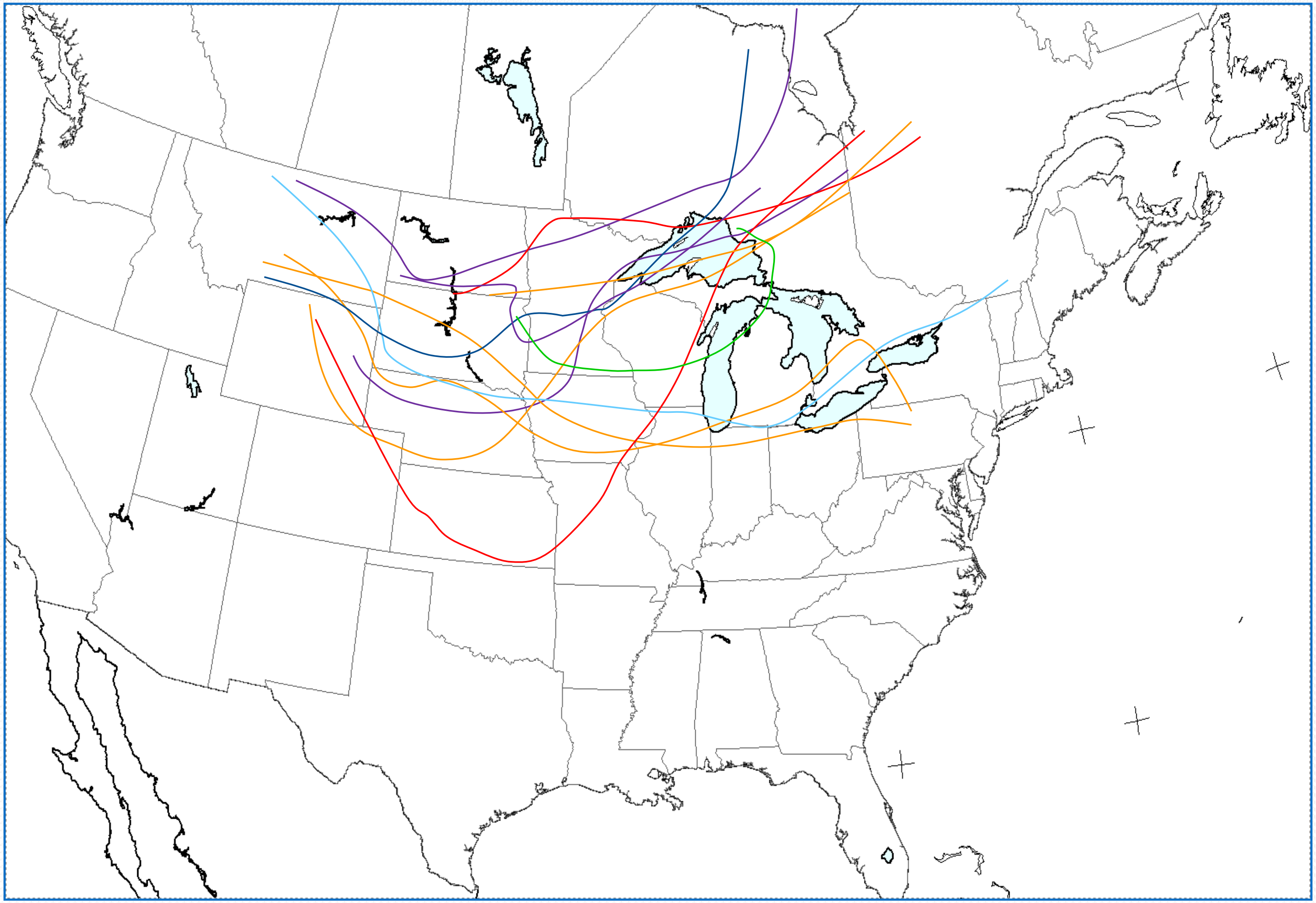
Birthplace of Alberta Clippers.

Tend to be fast moving...typically not as strong as other cyclones impacting the upper Lakes (992mb lowest average pressure).

Most clipper tracks are to the north of Michigan. Usually unable to tap moisture from Gulf of Mexico.

But this storm track can favor strong southwest flow lake enhanced snow bands into western Mackinac and Chippewa counties.

Geographic Region: Northern Plains

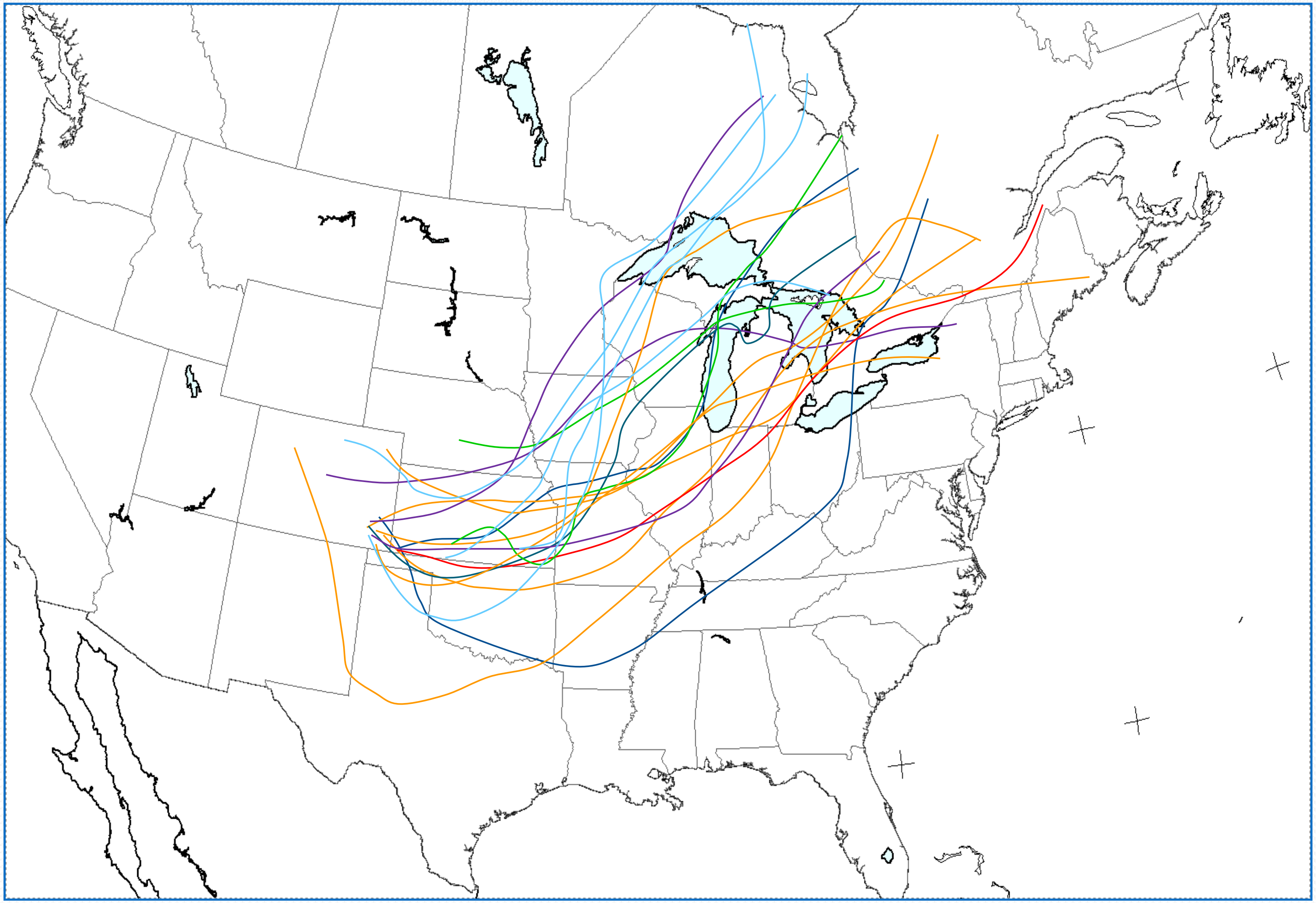


Tracks can be more "erratic". Most tracks remain north of 40^{o} N latitude.

Average lowest surface pressure of 992mb same as that for Canadian systems.

Most all tracks went "around" northern Michigan.

Geographic Region: Central Plains

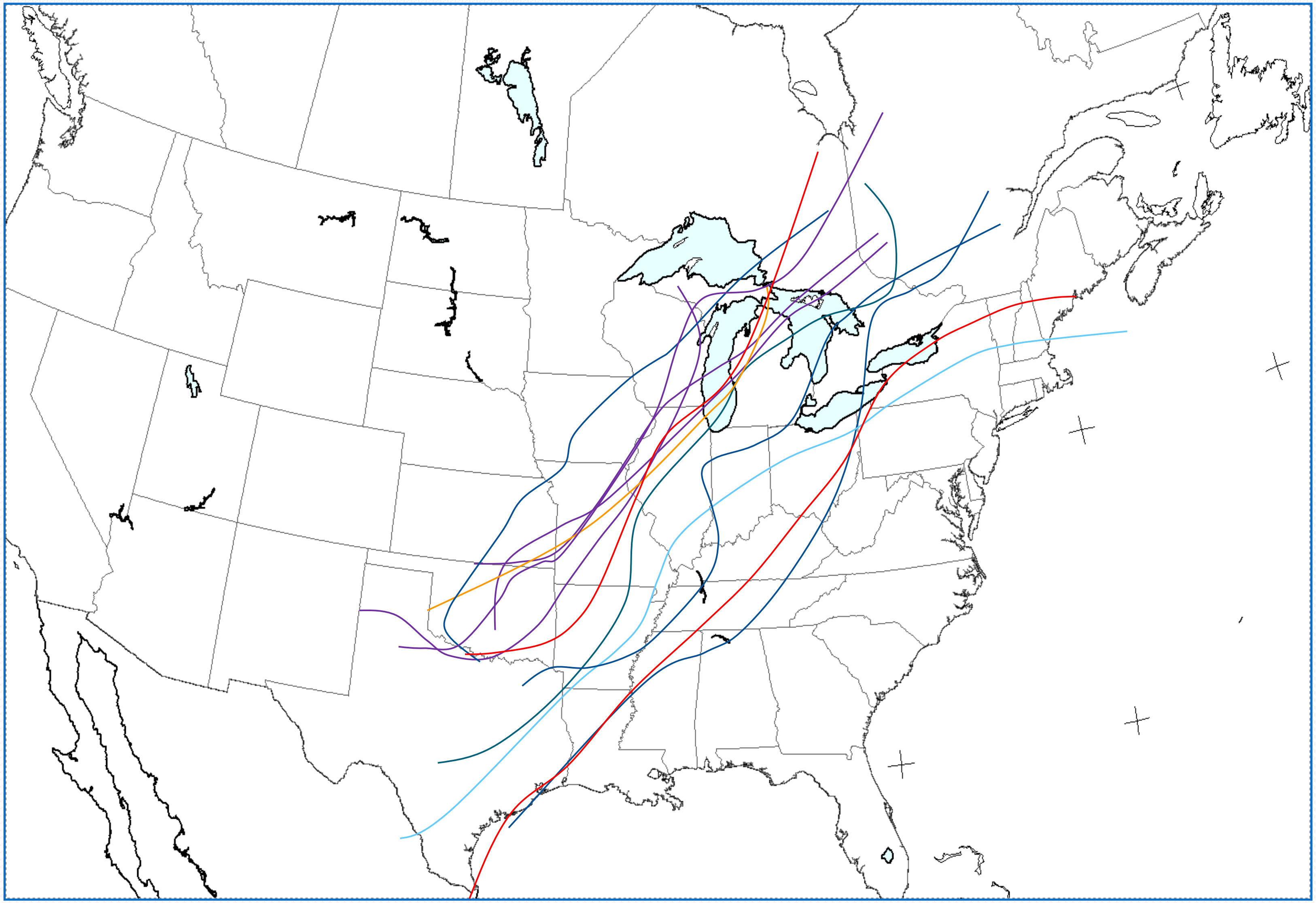


Most common area of cyclone formation in the database (18 storm tracks).

Tend to be more intense...990mb average lowest pressure . Two storms with minimum pressure 977mb=28.85 in.

Storms developing at lower latitudes have better access to Gulf moisture/ warm air. Leads to more storm track dependent issues with precipitation type.

Geographic Region: Southern Plains



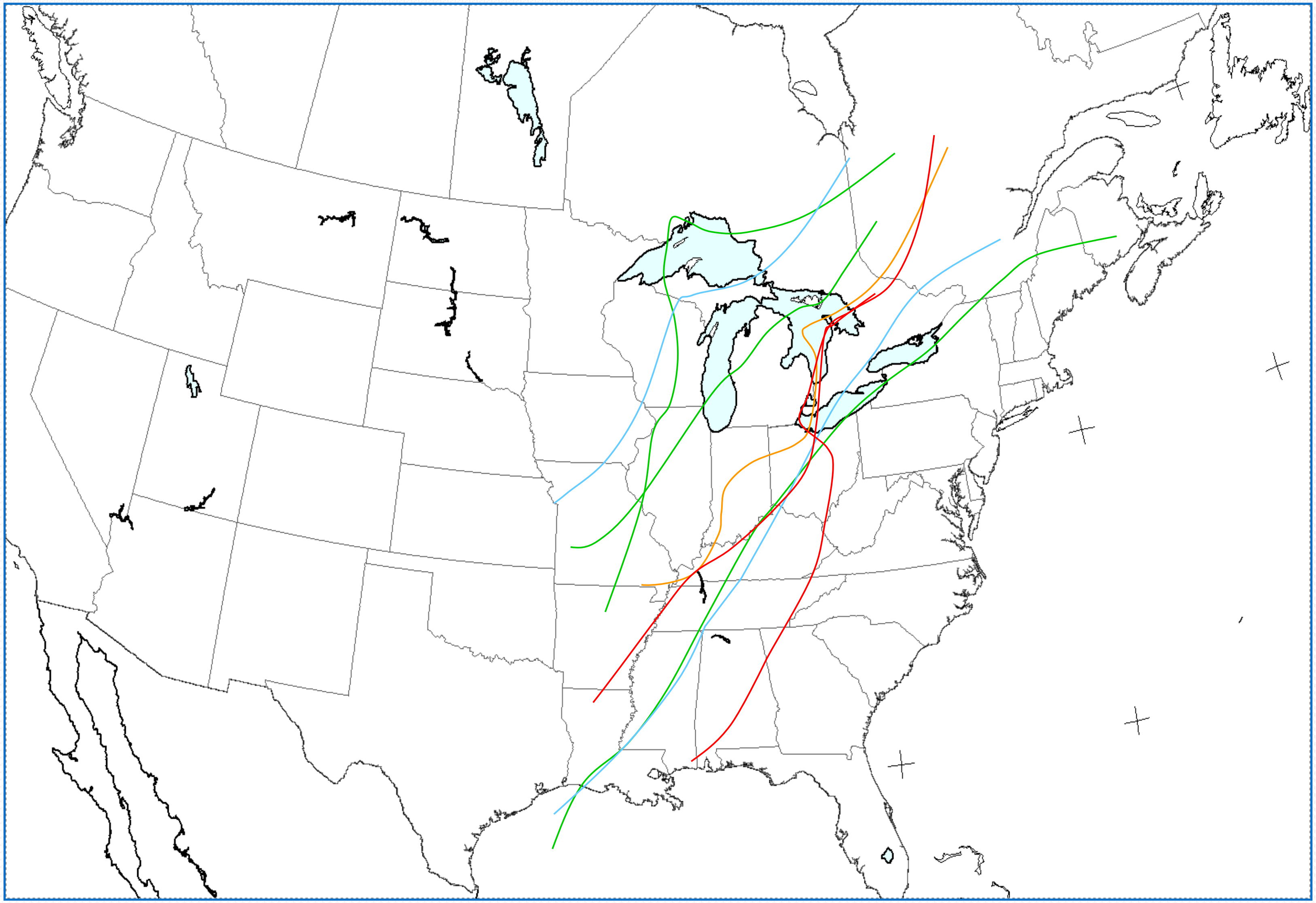
Another storm track that can more favorably tap low latitude warm/moist air.

Average minimum surface pressure 991mb.

Note preponderance of storm tracks right across northern Lower Michigan (all but one starts in Oklahoma).

Potential forecast nightmares with many impacts sensitive to exact storm track.

Geographic Region: Lower/Mid Mississippi Valley



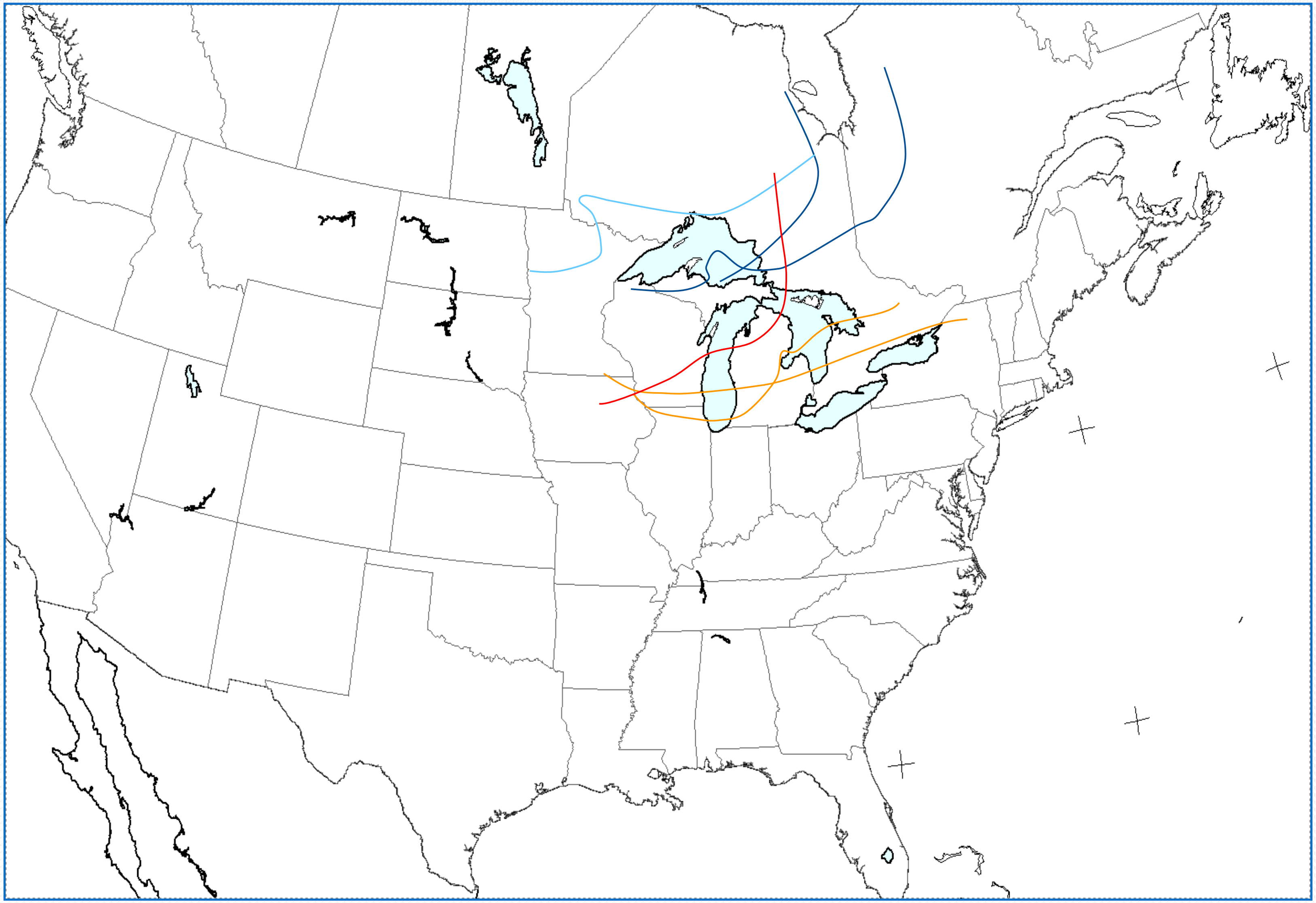
Fewer storms... but by far the most intense.

Average minimum surface pressure 983mb. Strongest storm in the database (974mb=28.76in).

Storms that develop over the lower Mississippi Valley tend to track across Lake Huron...a favorable storm track for heavy snow into eastern parts of Michigan.

The farther north a storm develops... the more likely it will track across Michigan.

Geographic Region: Upper Mississippi Valley/Great Lakes



Systems that develop quickly close in to the Upper Great Lakes.

Average minimum surface pressure 990mb.

Systems can be rather strong depending on the strength of the jet stream disturbance driving the development of the storm.

Some Conclusions:

Majority of significant cool season cyclones impacting the Great Lakes initially form downwind of the Rocky Mountains.

Most common area of development is across the Central Plains (eastern Colorado/Nebraska/Kansas).

Less common area of development is the lower/middle Mississippi Valley...but storms that develop here tend to be the strongest.

Thanks for your attention!